INL irradiation test designers Brandon Horkley and Ray Mitchell load experimental samples at INL's Test Train Assembly Facility. Research projects with the Electric Power Research Institute are directly supporting the U.S. nuclear energy industry.

Giving industry access to national laboratory capabilities

By Julie Ulrich, INL Communications & Governmental Affairs

Universities have many opportunities for access to research facilities, but private industry has fewer options when complex, high-end capabilities are needed to advance new technology. That is where public resources such as the U.S. Department of Energy's national laboratory complex play a role.

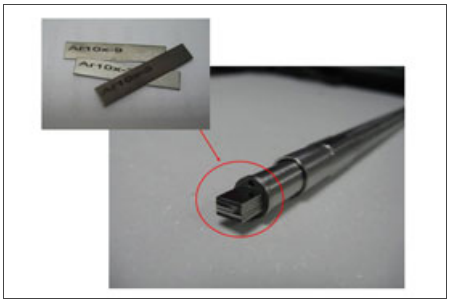
Many of the national research capabilities that are unique to nuclear energy reside at Idaho National Laboratory, the nation's lead nuclear energy lab. DOE made these capabilities more accessible to university research teams by establishing a National Scientific User Facility around INL's Advanced Test Reactor. Now, a new set of Advanced Test Reactor National Scientific User Facility (ATR NSUF) experiments is demonstrating how industry researchers also can access INL's distinctive capabilities.

Two research projects with the Electric Power Research Institute (EPRI) — a nonprofit research, development and demonstration organization for the electric utility industry — are directly supporting our nation's nuclear energy industry. Both experiments are cooperative research and development agreements that allow ATR NSUF and EPRI to share information and costs for the projects. One project will provide data that could help increase the robustness of cladding materials that surround and isolate nuclear fuel. Another supports nuclear reactor relicensing efforts by boosting understanding of factors that can limit the lifetimes of reactor structural materials. The projects build on work the ATR NSUF has been doing to enhance relevance for industry.

"Collaborative research between universities and industry is absolutely invaluable to both sides," said John Jackson, Ph.D., ATR NSUF Industry Programs lead and INL's principal investigator for the EPRI experiments. "The user facility concept represents a huge shift in the way research will be done for these companies. It is exciting for them and exciting for us."

What is ATR NSUF?

Since 2007, the Advanced Test Reactor (ATR) National Scientific User Facility (NSUF) has opened nuclear materials and fuels research capabilities at Idaho National Laboratory and 10 partner facilities to external researchers ("users") via university-led research. Now, two pilot projects with the Electric Power Research Institute are helping prototype a similar program for industry users. Two more industry user projects, smaller in scope, but equally important to initial success, are for the U.S. Nuclear Regulatory Commission and Atomic Energy of Canada Limited. For more information, visit atrnsuf.inl.gov.



EPRI Zirconium Growth experiment specimens in a partially assembled irradiation capsule prior to irradiation.

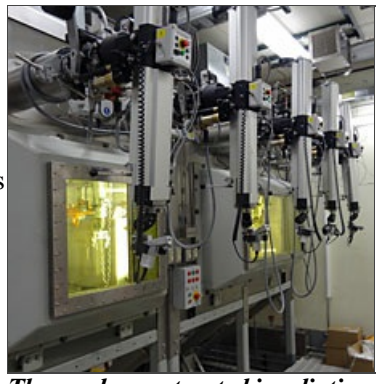
To ensure the program offers capabilities needed to support industry experiments, the ATR NSUF Industry Advisory Committee was created for regular interfacing with industry. Attendees at the most recent meeting in May 2012 included representatives from EPRI, as well as:

- Électricité de France, the second-largest electric utility company in the world
- U.S. Nuclear Regulatory Commission
- Materials Aging Institute, a French utility-run research center representing half the world's nuclear power station operators
- General Electric-Global Research Center, the research and development division of GE
- Duke Energy, the largest electric power holding company in the United States
- Rolls-Royce, a leading industry supplier of power systems and services
- Tohoku University, the third-oldest Imperial University in Japan
- Westinghouse Electric Company, a nuclear power company providing nuclear products and services to utility companies worldwide
- Areva NP, a French public multinational nuclear services company
- Ironwood Consulting, a nuclear energy consulting firm

The EPRI pilot experiments are paving the way for future industry use of the ATR National Scientific User Facility. One of the projects ("EPRI Zr Growth") is irradiating 200 specimens of various zirconium alloys to determine why reactor fuel channel cladding — the barrier between the fuel and reactor coolant — bows in service. Bowing could lead to cracks in the cladding and allow some fission products to escape into the coolant. Reactors are designed to deal with this using decontamination systems, which are expensive. Research and development on more robust

cladding materials could save money and protect personnel by minimizing the escape of fission products.

Another EPRI pilot project, focused on post-irradiation examination of reactor structural materials ("EPRI IASCC"), is looking at how metal alloys behave under irradiation in reactor environments. Specifically, the project will explore the growth behavior of irradiation-assisted stress corrosion cracks (IASCC) in two particular alloys, "X-750" (a nickel-based alloy) and "XM-19" (a nitrogen-strengthened austenitic stainless steel) within a typical light water reactor environment. Engineers already use these alloys in hardware — things like nuts and brackets — inside light water reactors. Stress corrosion cracking in reactor components tends to occur more frequently as a reactor ages.



The newly constructed irradiation-assisted stress corrosion crack (IASCC) test rig at INL's Materials and Fuels Complex.

The EPRI IASCC project experimenters fabricated three test capsules with specimens of X-750 and XM-19 alloys in each. Each capsule will be irradiated to different neutron fluence targets in ATR over the next year. Research and development on how these materials respond to irradiation contributes to the overall goal of extending the life of reactors and the components inside them. It also helps engineers optimize inspection intervals and predict component lifetimes.

The design, baseline characterization, irradiation, shipment, handling, and post-irradiation examination for the EPRI IASCC experiment all will be performed at INL, marking the first time an industry experiment will undergo this type of full-scale characterization here. Instead of having to ship the experiment to different laboratories to complete different stages of characterization, all aspects can be done at INL — a "one-stop shop."

The work is significant not only for the industry collaboration, but because this is the first time one of the ATR's coveted pressurized and chemistry-controlled experimental loops has been used by researchers outside the U.S. Navy. In the past, all five of the active loop test positions in ATR were reserved exclusively for Navy use, but the newly reactivated sixth loop, Loop 2A, is the first available for external user experimentation. Each pressurized water loop can be operated at the customer's desired pressure, temperature, flow, and water chemistry, independent of the conditions in the rest of the reactor. With a loop position, users nearly have their own customizable test reactor at their fingertips. Until now, capabilities like those offered with Loop 2A were not available to industry or universities in the United States.

EPRI IASCC experiment specimen packages prior to insertion into a test train.

Frances Marshall, ATR NSUF program manager, is looking forward to industry user program growth. "These tests (loop irradiation and IASCC characterization) are one of the highest priority research efforts for the light water reactor industry," Marshall said. "INL's ability to perform this work will increase our connection to the commercial nuclear power industry, as well as open up new opportunities for our ATR NSUF researchers to propose projects using these new capabilities."

The first of the three EPRI IASCC capsules begin irradiation in March, the second in late April, and the third in early 2014. After irradiation, the user experiment will be part of another laboratory first: the first to use the newly constructed IASCC test rig at INL's Materials and Fuels Complex. At MFC, capsules will undergo IASCC testing and fracture toughness testing using the brand new test rig.

"Collaboration among industry, national laboratories, and universities can only enhance the ATR NSUF's ability to solve technically challenging problems in a way that benefits everyone," said Jackson. "We look forward to performing more work to support industry research needs."

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